

## OCCURRENCE OF RUTIN IN PLANTS\*

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RUTIN has been known for more than a century to be a constituent of plants. It was first discovered in 1842 by August Weiss, a Nuremberg apothecary, who obtained it from the leaves of the garden rue (*Ruta graveolens*), whence its name. Subsequently, Bornträger (5) studied this compound, and being misled by the ease with which it dissolved in alkaline solutions, believed it to be an acid and so termed it "rutinic acid". There was much confusion among the early investigators relative to the characterization of rutin. This was due mainly to the fact that rutin was not easy to purify, and its extremely hygroscopic nature made it difficult to obtain accurate analytical values for carbon and hydrogen. It was not until 1896 that the composition of the sugar moiety was established by Schmidt (68) and the correct empirical formula,  $C_{27}H_{30}O_{16}$ , assigned. The early history of rutin has been reviewed by Perkin and Everest (59) and by Charaux (12, 13).

Rutin and the related flavonols were formerly used as dyestuffs for textile fibers, but were displaced by the synthetic dyes. Today only small quantities of the flavonols quercetin and quercitrin (in the form of orange and lemon flavine) are utilized as pigments.

The use of rutin as a medicinal agent has greatly stimulated production of this compound. Demands for this drug have prompted many investigators not only to re-evaluate old sources but also to search for new ones.

Since much of the older literature on the occurrence of rutin in plants is widely scattered and not readily accessible, and since we have had a number of requests for information of this kind, we thought it advisable to make this literature survey.

*Plants containing rutin:* It was found that rutin is widely distributed in the plant kingdom. At present at least 32 plant families and 65 plant species are known that contain it. Thirty-one of these are tabulated in Table I in alphabetical order according to the family

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TABLE I  
PLANTS CONTAINING RUTIN

Family	Genus and Species	Refer- ences	Rutin Content, % *
APOCYNACEAE	<i>Nerium odorum</i> Lam.	53	—
BORAGINACEAE	<i>Lithospermum officinale</i> Linn.	13	—
ARALIACEAE	<i>Hedera helix</i> Linn.	13	—
CAPPARIDACEAE	<i>Capparis spinosa</i> Linn. (Capers)	8, 13, 32, 63, 69, 92	0.32 (8)
CAPRIFOLIACEAE	<i>Sambucus canadensis</i> Linn. (Elder)	38, 66, 83	0.77, F (66); 3.5, L (83); 5.2, IF (83); 3.0, MF (83)
	<i>Sambucus nigra</i> Linn. ( <i>S. vulgaris</i> Lam.) (Elder)	13, 44	—
CRASSULACEAE	<i>Bryophyllum calycinum</i> Salisb. ( <i>B.</i> <i>pinnatum</i> , Kurg.)	85	L
	<i>Sedum acre</i> Linn.	48	—
CRUCIFERAE	<i>Bunias orientalis</i>	37	—
EMBETRACEAE	<i>Empetrum nigrum</i> Linn. (Smokeberry, crowberry)	36	—
EUPHORBIACEAE	<i>Mallotus japonicus</i> Muell Arg.	75	—
LOBULARIACEAE	<i>Globularia alypum</i> Linn.	82, 92	2.5, F (82)
	<i>Globularia vulgaris</i> Linn.	82, 92	—
HIPPOCASTANACEAE	<i>Aesculus californica</i> Nutt (Pavia C.)	13	—
LEGUMINOSAE	<i>Daviesia latifolia</i> R. Br. (Native hop- bush)	61	—
	<i>Sophora japonica</i> Linn. (Chinese scholar tree, Japanese pagoda tree)	19, 27, 47, 74, 78, 79, 81	3.0, F (81); 16.3-22.9, F (19)
	<i>Tephrosia purpurea</i> Pers. (Ash vetch)	14	2.5
LILIACEAE	<i>Asparagus officinalis</i> Linn.	11, 22, 52, 80	1.01, MP (80)
MAGNOLIACEAE	<i>Magnolia grandiflora</i> Linn.	60	—
	<i>Magnolia kobus</i> DC.	31	—
	<i>Magnolia macrophylla</i> Michx.	43	—
	<i>Magnolia obovata</i> Thunb	60	—
	<i>Magnolia soulangeana</i> Soul	60	—
	<i>Magnolia stellata</i> Maxim	60	—
	<i>Magnolia thompsoniana</i> Hort.	60	—
	<i>Magnolia umbrella</i> Lamb.	43	—
	<i>Magnolia yulan</i> Desf.	60, 88	2.4, F (60)

\* F = Flowers  
L = Leaves

IF = Immature Flowers  
MF = Mature Flowers  
MP = Mature Plant

Family	Genus and Species	References	Rutin Content, % *
MYRTACEAE	<i>Eucalyptus macrorrhyncha</i> F. v. M.	41, 45, 58, 64, 70, 76, 77	10.0, L (77); 13.7-23.1, L (41); 6.0- 24.0, L (64)
OLEACEAE	<i>Eucalyptus youmani</i> B. and McK. <i>Forsythia fortunei</i> Rehd. <i>Forsythia pendulata</i> Linn. <i>Forsythia suspensa</i> Vahl.	64 51 29 25, 51	6.8-11.0, L 2.08-4.29, F 0.36, F 1.09 F (51)
PALMAE	<i>Dactylifera palma</i> Linn. (Date palm)	24	0.36, PG
PAPAVERACEAE	<i>Eschscholtzia californica</i> Cham. <i>Hypecoum pendulum</i> Linn.	65 13	5.0, F —
PAPILIONATAE	<i>Onobrychis sativa</i> Lam.	4	0.3-0.4, P
POLYGONACEAE	<i>Fagopyrum cymosum</i> <i>Fagopyrum emarginatum</i> <i>Fagopyrum esculentum</i> Mnch. ( <i>Polygonum fagopyrum</i> Linn.) (Japanese buckwheat)	35 20 7, 18, 71, 72, 73, 91	4.0 (May) 8.5 (Oct) — 0.11, L (72); 1.78, L (91); 0.71, F (91); 2.0+, F (91); 1.16-6.37, L, F (18)
	<i>Fagopyrum tataricum</i> (Gaertn. (Tartary buckwheat))	20	3.4-5.0, P
	<i>Fagopyrum tetra-tataricum</i> S.	20	—
	<i>Muehlenbeckia chilensis</i> Meissn.	33, 34	2.4, P (33)
PROTEACEAE	<i>Grevillea robusta</i> Cunn.	39	0.52, L
RHAMNACEAE	<i>Paliurus aculeatus</i> Lam. ( <i>Rhamnus paliurus</i> Linn.)	57	0.15, GF
ROSACEAE	<i>Prunus melanocarpa</i> (A. Nels) Rydb. (Wild cherry)	15	1.44-3.88, L
RUBIACEAE	<i>Galium cruciatum</i> Linn.	13	—
RUTACEAE	<i>Citrus hybrid</i> <i>Ruta graveolens</i> Linn. (Garden rue)	40 5, 26, 32, 69, 87	0.9-3.2, PE 2.0, P (26)
SALICACEAE	<i>Salix triandra</i> Linn. ( <i>S. amygdalina</i> , <i>B-triandra</i> L.)	9	0.15-0.70
SANTALACEAE	<i>Osyris abyssinica</i> Hochst. <i>Osyris compressa</i> DC. (Cape sumach)	1 57, 58	— —
SAXIFRAGACEAE	<i>Hydrangea paniculata</i> (Grandiflora Sieb)	17	4.1, F

\* F = Flowers

P = Plants

L = Leaves

PE = Peel

GF = Green Fruit

PG = Pollen Grains

Family	Genus and Species	Refer- ences	Rutin Content, % *
SOLANACEAE	<i>Lycopersicum pimpinellifolium</i> (Red Currant Tomato)	28	0.037, L
	<i>Nicotiana glauca</i>	2, 13, 23	1.2-2.1, L (2)
	<i>Nicotiana rustica</i> Linn.	2	0.1-0.7, L (2)
	<i>Nicotiana tabacum</i> Linn.	16, 23, 30, 54, 55, 56	0.008-0.61; ave. 0.40, L (16)
	<i>Solanum angustifolium</i> R. and Pav.	84	0.75, P
	<i>Solanum demissum</i> Lindle	67	—
	<i>Solanum lycopersicum</i> Linn. (L. esculentum Mill.) (tomato)	3	—
	<i>Solanum tuberosum</i> Linn. (potato)	13	—
	<i>Bupleurum falcatum</i> Linn.	62	0.3-0.4, P
	<i>Heracleum spondylium</i> Linn.	13	—
VIOLACEAE	<i>Viola lutea splendens</i>	50	16.6, F
	<i>Viola tricolor</i> Linn. (Arvensis and vulgaris)	21, 46, 58, 70, 90	0.13, L; 0.08, S; 0.05, R (70); 2.0 (90)
	<i>Viola tricolor</i> Linn. Var. Maxima (Giant Roggli)	50	18.3-21.2, F
	<i>Viola tricolor</i> Linn. (Odorata)	6	—

\* F = Flowers

R = Roots

L = Leaves

S = Stems

P = Plants

name. References are given to the original investigators and to others who have contributed to the identification of rutin. When available, the percentage rutin content is also given.

In addition to the spermatophytes listed in Table I, rutin has also been isolated from a thallophyte. Kuhn and Low (42) isolated it from the gametes of a *Chlamydomonas* mutant, which they termed *Chlamydomonas agametus*.

In the quest for new sources of rutin, there will undoubtedly be much duplication of effort, since negative findings are not usually reported. In a search for steroid saponins, Wall et al. (86) are extending the screening of plant extracts to include other constituents, among which are flavonoids. Of approximately 1,000 plant samples from 29 families, listed in their initial report (86), about two-thirds of which were of the genera *Agave*, *Yucca*, and *Dioscorea*, most were devoid of flavonoids. But 33 samples are listed that contain flavonoids in trace amounts and 4 in moderate quantities. The test used in this work was the cyanidin reaction of Willstätter (89, 10) which, although not specific for rutin, indicates the presence of flavonoids.

*Plants containing no appreciable rutin:* During a routine examination at the Eastern Regional Research Laboratory, many domestic plants, the extracts of which gave a positive cyanidin test failed to yield rutin by the gravimetric technique of Naghski et al. (49), based on the isolation of the flavonoid. This method, however, is not sensitive to small quantities of rutin (less than 0.1%), and so plants containing only traces would escape detection. Plants in which no rutin was found by the gravimetric analysis are listed in Table II:

TABLE II  
PLANTS CONTAINING NO APPRECIABLE RUTIN

Family	Genus and Species	Part Examined
ANACARDIACEAE	<i>Rhus glabra</i> Linn. (sumac)	Fresh flowering heads
BALSAMINACEAE	<i>Impatiens pallida</i> Nutt. (Jewelweed)	Fresh whole plant
BERBERIDACEAE	<i>Podophyllum peltatum</i> Linn. (May-apple)	Fresh whole plant
BORAGINACEAE	<i>Borago officinalis</i> Linn. (Borage)	Fresh leaves
CANNABINOIDEAE	<i>Humulus lupulus</i> Linn. (Hop)	Dried flowers
CAPRIFOLIACEAE	<i>Viburnum opulus</i> Linn. (Snowball)	Fresh flowers
CARYOPHYLLACEAE	<i>Stellaria media</i> Vill. (Chickweed)	Fresh whole plant
CHENOPodiaceae	<i>Beta vulgaris</i> Linn. (Beet) Var. <i>cicla</i> (Swiss chard)	Fresh tops Fresh leaves
	<i>Spinacea oleracea</i> Linn. (Spinach)	Fresh leaf
	<i>Spiraea vanhouttei</i> Zabel (Spirea, Bridal wreath)	Fresh flowers
COMPOSITAE	<i>Aster novae-angliae</i> Linn. (New England aster) <i>Cichorium intybus</i> Linn. (Chicory) <i>Chrysanthemum carinatum</i> Schousb. <i>Chrysanthemum parthenium</i> Pers. (Feverfew) <i>Galinsoga ciliata</i> (Raf.) Blake <i>Lactuca sativa</i> Linn. (Lettuce)	Fresh flowers Fresh white flowers Fresh yellow flowers Fresh flowers
CONVOLVULACEAE	<i>Ipomoea batatas</i> Poir. (Sweet potato)	Fresh vines
CRUCIFERAE	<i>Brassica arvensis</i> Kuntze (Mustard weed) <i>Brassica oleracea</i> Linn. (Var. <i>acephala</i> , Kale; var. <i>Botrytis</i> Linn., Broccoli; var. <i>capitata alba</i> Linn., Cabbage)	Fresh yellow flowers Fresh flowering heads and attached leaflets
CUCURBITACEAE	<i>Cucurbita pepo</i> Linn. (Pumpkin)	Fresh ripe rind; Fresh blossoms
EQUISETACEAE	<i>Equisetum hiemale</i> Linn. (Horsetail or Scouring-rush)	Fresh whole plant
EUPHORBIACEAE	<i>Euphorbia epithymoides</i> Jacq. (E. polychroma Kern.) (Spurge)	Fresh whole plant
GNETACEAE	<i>Ephedra viridis</i> Wats. (Mexican-tea)	Dried whole plant
GRAMINEAE	<i>Holcus sorghum</i> Linn. (var. White Hegari) <i>Lolium perenne</i> Linn. (Ryegrass) <i>Setaria glauca</i> Beauv. (Yellow foxtail)	Fresh whole plant Fresh whole plant
IRIDACEAE	<i>Iris pseudacorus</i> Linn. (var. Seminole-Yellow flag)	Fresh flowers



Family	Genus and Species	Part Examined
PORTULACACEAE	<i>Portulaca oleracea</i> Linn. (Pusley)	Fresh whole plant
RANUNCULACEAE	<i>Paeonia</i> sp. (White peony) <i>Ranunculus bulbosus</i> Linn. (Common field buttercup)	Fresh flowers Fresh flowers
ROSACEAE	<i>Prunus serotina</i> Ehrh. (Wild black cherry)	Dried leaves
RUTACEAE	<i>Citrus aurantifolia</i> Swingle ( <i>Limonia aurantifolia</i> Ch.) (Lime) <i>Citrus grandis</i> Osbeck ( <i>Citrus decumana</i> Linn.) (Grapefruit) <i>Citrus limonia</i> Osbeck (Lemon)	Fresh immature peel and fruit Fresh mature peel and fruit Fresh immature peel and fruit
	<i>Citrus sinensis</i> Osbeck (Common orange)	Fresh mature peel and fruit
SAXIFRAGACEAE	<i>Hydrangea arborescens</i> Linn.  <i>Philadelphus coronarius</i> Linn. (Mock-orange)	Flowering heads and stipules only in early bud Fresh blossoms
SOLANCEAE	<i>Capsicum annuum</i> Linn. (Pepper) <i>Lycopersicon esculentum</i> Mill. ( <i>Solanum lycopersicum</i> Linn.) Var. Stone (Tomato)	Fresh immature fruit Vine and fruit (green and ripe)
UMBELLIFERAE	<i>Daucus carota</i> Linn., Var. <i>sativa</i> (Wild Queen-Anneslace) <i>Petroselinum hortense</i> Hoffm. (Parsley)	Flower head Fresh leaf
URTICACEAE	<i>Ramnium niveum</i> Linn. (Ramie)	Fresh tops and leaves
VIOLACEAE	<i>Viola papilionacea</i> Pursh. (Common violet)	Fresh white flowers

### Summary

A survey was made of literature on the occurrence of rutin in plants. Rutin has now been reported present in at least 32 plant families, representing at least 65 plant species. Examination of 80 species representing 21 additional families failed to show any rutin.

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